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Dr. Terry Allard
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Dear Terry:

I am writing this letter to inform you about progress on our project, "PET Studies of Components of High-Level Vision" (N00014-91-J-1243). We have made progress primarily by testing more subjects in four PET experiments, developing new software for data analysis, and carrying out preliminary data analyses. It is premature to report the results in detail, but some intriguing trends are evident in the images, as noted below.

Canonical and noncanonical views during object identification

As discussed in earlier reports, this study is designed to allow us to test a prediction of Kosslyn, Flynn, Amsterdam and Wang (1990); our theory led us to expect processes in the parietal lobe (involved in shifting attention) and in the frontal lobe (involved in formulating hypotheses) to be invoked when subjects identify pictures of objects seen from an unusual point of view but not when objects are seen from canonical points of view. To refresh your memory: The subjects participated in three conditions: 1) They saw a series of pictures of objects seen from a canonical point of view; 2) they saw a series of pictures of objects seen from an unusual point of view; 3) they saw random noise patterns. In all three conditions, the subjects heard a word when each picture was presented. In the first two conditions, they verified whether the word named the picture; in the third (baseline) condition, they simply pressed a pedal when they hear the word. The preliminary results are encouraging, in that the frontal lobes in particular do appear to play a special role when objects are seen from unusual points of view.

Imagery and retinotopic mapping

We have also tested subjects in a new imagery task. As noted in the previous report, these subjects closed their eyes and visualized upper case letters of the alphabet, and then decided whether each letter has any curved lines. In one condition, they visualized the letters as if they are seen at a tiny size, and in another condition they visualized the letters as if they are seen at a larger size. We found that subjects can evaluate the "larger" images more quickly than the smaller ones, replicating results originally reported by Kosslyn (1975). In addition, preliminary analysis suggests that more of area V1 is activated by the larger

images. Indeed, there is a hint that the smaller images resulted in more posterior activation, as we expected (the fovea is represented at the posterior part of V1), but we must be cautious about drawing any conclusions until the data are fully analyzed. These preliminary findings are particularly exciting because the subjects a) had their eyes closed during the tasks, and so eye movements and the like cannot play a role in the activation of area V1, and b) they evaluated the larger images more quickly, and so the apparent findings--if they hold up statistically--cannot simply reflect differences in the overall difficulty of the conditions. We plan to test two more subjects in this experiment. In addition, we have tested one person using the new "echoplanar MRI" technique developed at MGH, and--somewhat to our surprise--got promising results! These very preliminary findings appear consistent with what we are finding using PET, and we plan to test additional subjects using this technique in the near future.

Imagery activation and eye movements

In part because of your concerns about the role of eye movements in our previous imagery experiment, we replicated the original imagery experiment, with two changes. We repeated the imagery condition but now present the grid for only 200 ms, which is not enough time to make an eye movement. In addition, we considered why we found greater activation of V1 during imagery than during perception; this finding is a bit surprising--we only needed to demonstrate that imagery activates V1 compared to no imagery (which we did in our previous PET study by comparing imagery to a sensory-motor control condition), not that imagery engenders more activation in V1. We hypothesized that this difference arose because visual memories are fragmentary, and hence additional information had to be filled in during imagery than during perception. If so, then if the perceptual stimuli were degraded, then we expected increased activation in V1. Thus, in the perception task we made the X marks dimmer and also reduced the contrast between the letter and non-letter grid cells, thereby making it more difficult to distinguish the letter from its background. These stimuli were also presented for only 200 ms. We used a simple picture-naming control condition as a baseline against which to compare both the imagery and perception conditions. Our very preliminary analyses indicate that the imagery task does indeed activate area V1, relative to the activation we find when subjects name pictures; also as expected, our manipulation in the perception condition engendered more posterior blood flow in this task than we found previously. In addition, the other areas that were activated in the previous experiment continue to be activated. This is particularly interesting regarding the anterior cingulate, which was very active previously and in the present experiments. The fact that this area again was more active during imagery than during the perception task appears to rule out the theory that this area is involved in response preparation: not only did subjects make the same type of response in both conditions, but they actually made more responses during the perception condition (the trials were self-paced, and the subjects evaluated more perception trials). We shortly will be writing up the entire set of imagery experiments for publication.

Pictures versus words

Finally, we have tested five subjects in a new experiment, comparing word perception and picture perception. The early experiments reported by the St. Louis group made much out of localized cerebral activation engendered by visual

words; Posner and his colleagues argued that they had found where the "visual word form" system was implemented. However, these experiments never controlled for the possibility that any familiar visual line pattern might be processed in those areas. Indeed, the theory my colleagues and I have been developing suggests that words are initially treated in the same way as other patterns of lines--and it is not clear whether a distinct visual processing system does in fact develop. In this experiment we replicate the original "passive word perception" condition of Petersen et al., and also present a baseline condition (random lines, with the same number of dark pixels as the words, unlike the single cross-hair control used previously), and also present a "passive picture perception condition." In this picture perception condition, subjects view pictures of common objects; the pictures have the same number of dark pixels as the words. It is of interest to discover whether words and pictures activate the same posterior areas. We have not yet begun to analyze these data.

In short, we have made substantial progress over the course of the last quarter. We expect to have all of these PET experiments completed within the next month, at which point we will turn to writing reports of the results in earnest.

We again thank you for your support.

Sincerely,

Stephen M. Kosslyn
Professor